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Effect of NAA (Napthaleneacetic acid) and 2, 4, 5-T (2, 4, 5-Trichlorophenoxyacetic acid) on fruit quality of apple cv. red delicious

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Abstract
This explore was conducted to study the effect of NAA (Napthaleneacetic acid) and 2,4,5-T (2,4,5-Trichlorophenoxyacetic acid) on fruit quality of apple cv. Red Delicious. The highest soluble solid content (12.04˚B) and total sugars (9.70%) was found under T_2 (Napthaleneacetic acid @ 20ppm) followed by T_4 while as highest ascorbic acid content was recorded under T_4 (5.58mg/100g). Fruit firmness of apple decreased significantly with the growth regulator treatments over control. Minimum fruit firmness 17.27 lb/inch^2 was recorded in T_2 (NAA @ 20ppm) followed by T_1 (NAA @ 10ppm) and the maximum fruit firmness was recorded under control (17.59 lb/inch^2). NAA and 2,4,5-T significantly differed with each other in lowering the starch content of fruits, however NAA @ 20ppm (6.78) being more effective than the 2,4,5-T @30ppm (6.75) in reducing the starch content of fruits. The TSS, total sugars was improved by growth regulators, while as malic acid percentage was lowered compared to untreated fruits. The sugars exhibited an increasing trend with the growth regulators. The effect of NAA on TSS and total sugars was observed more pronounced than 2,4,5-T. However, NAA promotes more ripening in apples, accelerated starch degradation, increased rot%, decreased fruit firmness and ultimately affected the fruit quality parameters.

Keywords: NAA, 2,4,5-T, quality, sugars, ascorbic acid, malic acid

Introduction
Apple (*Malus* × *domestica* Borkh.) may be a normal temperate fruit having a place to family Rosaceae and sub-family Pomoidae. In Jammu and Kashmir, Red Delicious cultivar of apple has been broadly acknowledged by the cultivators since of its engaging colour and financial picks up, contributing to more than 80% of generation and range beneath apple. From dietary point of see its significance in day by day eat less is obvious from an ancient saying "an apple a day keeps the doctor away". It diminishes the rate of dental caries, makes a difference to control the weight and supplies additional vitality for overwhelming work out. Lurie [10] found that application of 3,5,6 TPA and 2,4-D +NAA moved forward fruit quality of apricot at gather or after capacity, in any case, application of 2,4-DP –P caused serious inside browning after capacity.

It has been reported that NAA when applied on early apple varieties stimulate ethylene production. However, Curry [5] observed that 1- Napthaleneacetic acid (NAA) when applied pre-harvest on late maturing varieties such as Delicious or Fuji apples suppresses ethylene production and delays loss of firmness after harvest. The consider assist uncovered that that one application of NAA may delay apple fruit drop for 10-14 days after treatment and rehashed applications of NAA delay fruit abscission more than single applications. Be that as it may, fruit softening is more often than not expanded by two applications of NAA or warm climate after the primary application. (Yuan and Carbaugh). [15] Ashraf *et al.* [3] conducted an test to see the impact of 2,4-D in Kinnow and watched progressed natural product weight, more number of fruits per plant, juice rate, add up to solvent solids (TSS) ascorbic acid substance, acidity, TSS/acid proportion and decreased the fruit drop. Nawaz *et al.* [11] examined the impact of foliar showers of 2,4-D at 10, 20 and 30 ppm in Kinnow mandarin and found most reduced fruit drop of 12.95 per cent, expanded number of fruits/plant and fruit weight/plant.

In this case most extreme TSS (12.03%) Diminishing sugars (3.44%) Non-reducing sugars (5.75) and Add up to sugars (8.86%) were found in 30ppm 2, 4-D and least acidity (0.78%) was found in 10ppm 2, 4-D.

Materials and Methods

The present investigation was carried out in a private orchard at village Mehmoodabad of Dooru, District Anantnag, during 2017-2018. The experiment was carried out on 80 trees which were 17 years old uniform and healthy apple trees of Cv. Red Delicious planted on sandy loam soil planted under 6×6 m spacing were used for the experimentation. Individual limbs were selected as experimental units. All cultural practices like hoeing, fertilization, weeding and sprays against pests and diseases were adopted as per the SKUAST-K recommended package of practice during the course of studies. Two growth regulators *viz*, α-napthalene acetic acid (10ppm and 20ppm) and 2, 4, 5-trichlorophenoxyacetic acid (15ppm and 30ppm) were sprayed four times. Accordingly four dates for four stages of spraying were fixed at 1st September, 8th September, 15th September and 23rd September, with the first October as the anticipated/expected date of harvest. The spraying of chemicals were thus designated as 4WBAH, 3WBAH, 2WBAH and 1WBAH (WBAH = Weeks Before date of Anticipated Harvest). Eighty trees (four limbs from each tree in every direction) of Red Delicious apple trees of uniform size and vigour were selected. The selected branches were carefully marked and tagged. The treatments were assigned to the selected limbs in a Randomized Complete Block Design (RCBD) with four replications. The fruit of each treatment were harvested at optimum maturity and were analyzed for different parameters. The fruit firmness was measured with the help of Effegi model penetrometer FT 3-27 with 11 mm probe, by removing a thin slice of skin with a stainless steel blade. Average of two measurements diagonal to each other were taken on each fruit and the results were expressed in lb per square inch. The Soluble Solids Contents (SSC) was decided with the assistance of Erma make Japan hand refractometer (0-32% run) in °Brix by putting a drop of juice on the crystal and taking perusing at room temperature. A temperature redress was connected where the readings were made at temperature other than 20°C (Ranganna). [13] Fruit acidity, Ascorbic acid, Total sugars, reducing non-reducing sugars were calculated as per the strategies laid out by Ranganna. Starch-iodine tests of cut fruits were carried out by utilizing the Cornell Generic Starch-Iodine Index Chart, where 1 = 100% starch and 8 = 0% starch (Blanpied and Silsby). [4]

Results and Discussions

Effect of plant growth regulators on Soluble solid content, acidity and ascorbic acid of Apple cv. Red Delicious

The data pertaining to the effect of growth regulators on soluble solid content is presented in table 1. It is evident from the data that soluble solid content of apple increased significantly with the growth regulator treatments over control (11.32 ˚B). Maximum soluble solid content 12.04˚B was recorded in T_2 (NAA@ 20ppm) followed by T_3 (2,4,5-T @ 15ppm) 11.76˚B.

The application of growth regulators at different stages are shown to differ significantly in effect. The data revealed that NAA was more effective in increasing the soluble solid content as compared to 2,4,5-T. It is evident from the data that both the growth regulators were effective in increasing the soluble solid content when applied 1 week before anticipated harvest.

The interaction effect of growth regulators applied at various stages on soluble solid content showed a significant effect. The study further revealed that maximum soluble solid content (12.42˚B) was recorded in T_3S_3 followed by T_1S_3(12.18˚B) which were statistically at par with T_2S_2 (12.16˚B). Li and Yuan [9] reported that NAA significantly increased the total soluble solid content in Delicious apples. Kvikliene *et al.* [8] observed that Pomonit Super 050SL (5% triethanolamine salt of NAA) alone and in mixture with Agrostym 480 SL (48% of ethephon) increased the soluble solid content in Auksis apple. Khandaker *et al.* [6] described that the TSS of Wax apple fruits were improved after NAA treatments.

The data pertaining to the effect of growth regulators on acidity is presented in table 1. It is evident from the data that acidity of apple decreased significantly with the growth regulator treatments over control (0.255%). Maximum acidity was recorded in control (0.255%) followed by T_3 0.238% (2,4,5-T @ 15ppm). The application of growth regulators at different stages are shown to differ significantly in effect. The data revealed that NAA was more effective in decreasing the acidity as compared to 2,4,5-T. It is evident from the data that both of the growth regulators were effective in decreasing the acidity when applied 1 week before anticipated harvest. The interaction effect of growth regulators applied at various stages on acidity showed a significant effect. The study further revealed that maximum acidity (0.246%) was recorded in T_3S_1 followed by T_1S_1 (0.237%) which were statistically at par with T_4S_1 (0.236%). 20ppm NAA and 30ppm 2,4,5-T were comparatively more influential, than lower ratings, in reducing the acidity. Because NAA promote more conversion of starch into sugars (Wargo *et al.*). [14]

The data on ascorbic acid is presented in Table 1.The growth regulator have recorded a significant increase in Ascorbic acid content of fruits over control (4.72 mg/100g). Further data in Table 13 reveals that NAA and 2,4,5-T differed significantly between each other in effect. 2,4,5-T (5.58 mg/100g)) being more effective than NAA (4.94 mg/100g). The application of treatments at different timings shows significant difference in effect on the Ascorbic acid content of fruits. Spraying at 4WBAH, 3WBAH, 2WBAH

and 1WBAH (weeks before anticipated harvesting) recorded an average, ascorbic acid content of 5.11mg/100g, 5.08 mg/100g, 5.07 mg/100g and 5.05 mg/100g respectively. Observations on interactions of growth regulators and stages of spray indicate that there existed a significant difference in their effect. NAA and 2,4,5-T applied at any timing (4WBAH, 3WBAH, 2WBAH and 1WBAH) registered a decreasing trend on the ascorbic acid content of treated fruits. Increase in ascorbic acid content of fruit may be due to catalytic activity of 2,4,5-T on its biosynthesis from its precursor glucose-6-phosphte or inhibition of its conversion into dehydro ascorbic acid by enzyme ascorbic acid oxidase or both. The results are in conformity with Abdel-Sattar *et al.* [1]

Table 1: Effect of differrent concentrations of plant growth regulators on SSC, Acidity and Ascorbic acid of apple cv. Red Delicious

Stage of application PGR'S	SSC (°B)					Acidity (%)					Ascorbic acid (mg/100g)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
NAA @ 10ppm (T1)	11.08	11.27	12.18	11.93	11.61	0.237	0.243	0.226	0.219	0.231	4.83	4.73	4.64	4.70	4.73
NAA @ 20ppm (T2)	12.05	12.16	12.06	11.92	12.04	0.229	0.214	0.216	0.210	0.217	5.05	4.92	4.85	4.96	4.94
2,4,5-T @ 15ppm (T3)	11.14	11.43	12.42	12.05	11.76	0.246	0.245	0.236	0.226	0.238	5.43	5.44	5.45	5.36	5.42
2,4,5-T @ 30ppm (T4)	11.48	11.93	11.35	11.72	11.62	0.236	0.225	0.216	0.205	0.220	5.63	5.56	5.64	5.51	5.58
Control (T5)	11.06	11.23	11.16	11.83	11.32	0.263	0.253	0.255	0.249	0.255	4.64	4.77	4.74	4.74	4.72
Mean	11.36	11.60	11.83	11.89		0.242	0.236	0.230	0.222		5.11	5.08	5.07	5.05	
CD ($p \leq 0.05$)	Treatments = 0.054 Stages = 0.048 Treatments × Stages = 0.108					Treatments = 0.004 Stages = 0.003 Treatments × Stages = 0.007					Treatments = 0.032 Stages = 0.029 Treatments × Stages = 0.064				

Effect of plant growth regulators on total sugars, reducing sugars and non-reducing sugars of apple cv. Red Delicious

The data pertaining to the effect of growth regulators on total sugars is presented in table 2. It is evident from the data that total sugars of apple increased significantly with the growth regulator treatments over control (9.34%). Maximum total sugars 9.70% was recorded in T_2 (NAA@ 20ppm) followed by T_4 (2,4,5-T @ 30ppm) 9.60%.

The application of growth regulators at different stages are shown to differ significantly in effect. The data revealed that NAA was more effective in increasing the total sugars as compared to 2,4,5-T. It is evident from the data that both the growth regulators were effective in increasing the total sugars when applied 1 week before anticipated harvest. The interaction effect of growth regulators applied at various stages on total sugars showed a significant effect. The study further revealed that maximum total sugars (9.86%) was recorded in T_2S_4 followed by T_4S_4(9.75%).

The data pertaining to the effect of growth regulators on reducing sugars is presented in table 2. It is evident from the data that reducing sugars of apple increased significantly with the growth regulator treatments over control. Maximum reducing sugars 8.32% was recorded in T_2 (NAA@ 20ppm) followed by T_4 (2,4,5-T @ 30ppm) 8.21%. The application of growth regulators at different stages are shown to differ significantly in effect. The data revealed that NAA was more effective in increasing the reducing sugars as compared to 2,4,5-T. It is evident from the data that both the growth regulators were effective in increasing the reducing sugars when applied 1 week before anticipated harvest.

The interaction effect of growth regulators applied at various stages on reducing sugars showed a significant effect. The study further revealed that maximum reducing sugars (8.50%) was recorded in T_2S_4 followed by T_2S_3 (8.38%).

The data pertaining to the effect of growth regulators on non-reducing sugars is presented in table 2. It is evident from the data that non- reducing sugars of apple decreased significantly with the growth regulator treatments over control (1.88%). Maximum non- reducing sugars 1.60% was recorded in T_1 (NAA@ 10ppm) followed by T_3 (2,4,5-T @ 15ppm) 1.59%. Application of growth regulators at different timings are shown to differ significantly in effect. It is evident from the data that both the growth regulators were effective in decreasing the non-reducing sugars when applied 1 week before anticipated harvest. Amros *et al.* [2] reported that NAA was helpful in improving the fruit quality in terms of total sugars and reducing Sugars in Loquat. Khunte *et al.* [7] reported that total sugar of strawberry fruits treated with NAA were higher.

Table 2: Effect of different concentrations of plant growth regulators on total sugars, reducing sugars and non- reducing sugars of apple cv. Red Delicious

Stage of application PGR'S	Total sugars (%)					Reducing sugars (%)					Non-Reducing sugars (%)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
NAA @ 10ppm (T1)	9.26	9.35	9.46	9.53	9.40	7.65	7.76	7.84	7.95	7.80	1.61	1.59	1.62	1.58	1.60
NAA @ 20ppm (T2)	9.55	9.64	9.75	9.86	9.70	8.14	8.25	8.38	8.50	8.32	1.41	1.39	1.37	1.36	1.38
2,4,5-T @ 15ppm (T3)	9.37	9.45	9.55	9.62	9.50	7.75	7.84	7.95	8.05	7.90	1.62	1.61	1.60	1.56	1.59
2,4,5-T @ 30ppm (T4)	9.45	9.55	9.66	9.74	9.60	8.06	8.16	8.26	8.35	8.21	1.40	1.39	1.39	1.38	1.39
Control (T5)	9.23	9.29	9.37	9.46	9.34	7.28	7.38	7.51	7.63	7.45	1.95	1.90	1.86	1.83	1.88
Mean	9.37	9.46	9.56	9.64		7.77	7.88	7.99	8.01		1.59	1.58	1.57	1.54	
CD ($p \leq 0.05$)	Treatments = 0.012 Stages = 0.011 Treatments × Stages = 0.024					Treatments = 0.007 Stages = 0.006 Treatments × Stages = 0.013					Treatments = 0.015 Stages = 0.013 Treatments × Stages = 0.029				

Effect of plant growth regulators on starch iodine rating and firmness of apple cv. Red Delicious

Observations on the table 3 indicates that there existed a significant difference of growth regulator treatments on the starch content of fruits over the control (5.93). NAA and 2,4,5-T significantly differed with each other in lowering the starch content of fruits, however former (6.78) being more effective than the latter (6.75) in reducing the starch content of fruits.

Application of treatments at different timings shows significant difference in effect on the starch content of fruits (Table 3). Spraying at 4WBAH, 3WBAH, 2WBAH and 1WBAH (weeks before anticipated harvesting) recorded an average, starch content of 5.54, 6.39, 6.74 and 7.40 respectively. Observations on interactions of growth regulators and stages of spray indicate that there existed a significant difference in their effect (Table 3). NAA and 2,4,5-T applied at any timing (4WBAH, 3WBAH,2WBAH and 1WBAH) registered a decreasing trend on the starch content of treated fruits. This might be due to the fact that Starch is degraded and converted into sugar and continuous hydrolysis of starch results in decreased starch content of fruits. Ozturk *et al.* [12] and Li and Yuan [9] reported that the starch degradation of NAA treated fruits was faster than the control apple fruits.

The data pertaining to the effect of growth regulators on fruit firmness is presented in table 3. It is evident from the data that fruit firmness of apple decreased significantly with the growth regulator treatments over control. Minimum fruit firmness 17.27 lb/inch^2 was recorded in T_2 (NAA @ 20ppm) followed by T_1 (NAA @ 10ppm) and the maximum fruit firmness was recorded under control (17.59 lb/inch^2).

The application of growth regulators at different stages are shown to differ significantly in effect. The data revealed that NAA was more effective in decreasing the fruit firmness as compared to 2,4,5-T. It is evident from the data that both of the growth regulators were effective in decreasing the fruit firmness when applied 1 week before anticipated harvest. The interaction effect of growth regulators applied at various stages on fruit firmness showed a significant effect. The study further revealed that maximum fruit firmness (17.60 lb/inch^2) was recorded in T_4S_1 followed by T_3S_1 (17.55 lb/inch^2). lb/inch^2). This decrease in fruit firmness might be due to the fact that auxins promote ripeneing or endogenous ethylene synthesis in apple fruits (Yuan and Carbaugh) [15]

Table 3: Effect of different concentrations of plant growth regulators on starch iodine rating and firmness of apple cv. Red Delicious

Stage of application PGR'S	Starch rating (1-8)					Firmness (lb/inch^2)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
NAA @ 10ppm (T1)	5.68	6.44	6.77	7.48	6.59	17.54	17.39	17.28	17.19	17.35
NAA @ 20ppm (T2)	5.77	6.77	6.94	7.66	6.78	17.36	17.35	17.23	17.15	17.27
2,4,5-T @ 15ppm (T3)	5.59	6.41	6.72	7.39	6.53	17.55	17.54	17.52	17.45	17.52
2,4,5-T @ 30ppm (T4)	5.73	6.76	6.87	7.65	6.75	17.60	17.57	17.53	17.43	17.53
Control (T5)	4.96	5.56	6.38	6.83	5.93	17.66	17.63	17.55	17.49	17.59
Mean	5.54	6.39	6.74	7.40		17.54	17.50	17.42	17.34	
CD ($p \leq 0.05$)	Treatments = 0.022 Stages = 0.020 Treatments × Stages = 0.044					Treatments = 0.02 Stages = 0.02 Treatments × Stages = 0.04				

Conclusion

From the present investigation, it can be concluded that the most of the quality parameters recorded (SSC, sugars etc) improved with application of growth regulators. The effect of NAA on SSC and total sugars were more pronounced than 2,4,5-T. However, application of NAA accelerated starch degradation, increased rot percentage and decreased fruit firmness more than 2,4,5-T resulting in fruit softening and ultimately affected fruit quality parameters.

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